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(54) Method and apparatus for rotating an advancing sheet

(57) A sheet advancing over a transport plane (2) by transport roller pairs (14, 15) is rotated through an angle of 90° by retaining the sheet at a point by a rubber cup (33) and coupled therewith releasing one of the transport roller pairs (15) so that only the other transport roller pair (14) exerts a torque on the sheet. By disposing the transport roller pair (14) exerting the torque somewhat downstream of the centre of rotation (33) the sheet is kept taut during rotation.

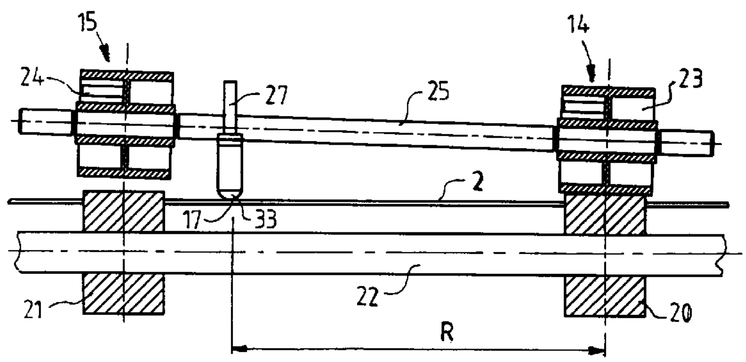

FIG. 5

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Description

The invention relates to a method of rotating a sheet advanced in a straight line in a direction of advance in a transport plane by transport means, by retaining the sheet at a centre of rotation. A method of this kind is known from US patent 4 445 679 which describes a method in which during retention of an advancing sheet at the centre of rotation slip occurs between the sheet transport means and the sheet. The sheet transport means must be able to allow such slip, e.g. by making the transport means relatively smooth and/or pressing it against the sheet with a relatively minor force. In these conditions there is the risk that when a sheet is rotated which has a relatively smooth surface the sheet will slip as a whole so that the required rotation is incomplete and on rotation of a relatively thin sheet and/or a sheet with a rough surface the sheet will not slip but will be teared or creased.

The object of the invention is to provide a method which does not have these disadvantages.

To this end, in a method according to the preamble, the invention is characterised in that during the rotation the transport means forms solely a first transport nip which, as considered in a direction transversely of the direction in which the sheet is advanced in a straight line, is situated at a fixed distance from the centre of rotation on a line between the first transport nip and said centre of rotation which line includes an angle of between 70 and 90° with the direction of advance. Consequently, a sheet can be reliably rotated in simple manner with the sheet transport means operating continuously.

Preferably, the angle is between 85 and 95°. Consequently, the frictional force exerted by the sheet transport means on the sheet during rotation thereof has a small component which keeps the sheet taut between the centre of rotation and the first transport nip so that creasing is reliably avoided, but without the said small component becoming so large that the sheet or the image thereon is damaged.

Furthermore, preferably, prior to and subsequent to the execution of a rotary movement the sheet is also advanced through a second transport nip which, as considered in the direction in which the sheet advances in a straight line, is in an identical position to the first transport nip.
This minimises the risk of skewing before and after rotation.

An apparatus for performing the latter method comprises retaining means movable between a first position in which they are free of an advancing sheet and a second position in which they retain the sheet at the centre of rotation, and is characterised in that coupling means are provided between the retaining means and the sheet transport means and on movement of the retaining means from the first position to the second position move the sheet transport means from a position in which the second transport nip is closed to a position in which the second transport nip is open. This is a simple construction to ensure that no slipping transport nip is operative during the rotation of a sheet.

If the first and second transport nips are formed by two pressure rollers fixed on a common shaft and if the shaft is lifted at the second transport nip when the second transport nip is opened, the pressure roller is shifted upwards from the first transport nip to form a punctiform first transport nip which reduces slip in the first transport nip still further.

In an attractive embodiment of an apparatus according to the invention, the first transport nip is situated at a predetermined distance from an upstream sheet feed nip which is smaller than the length of the shortest sheet for processing and a sheet discharge nip situated downstream of the first transport nip is located at a predetermined distance from the sheet feed nip somewhat greater than the diagonal of the largest sheet for rotation. Consequently, a sheet is rotated about a centre of rotation a short distance from the original leading edge and the sheet edge which becomes the leading edge after a quarter revolution rotation is situated a greater distance downstream of the centre of rotation so that the sheet can be discharged relatively rapidly from the rotational zone.

Other features and advantages of the invention will be explained with reference to the accompanying drawings wherein:

Fig. 1 is a side elevation of a rotating device according to the invention disposed between a printing apparatus and a folding device.
Fig. 2 is a cross-section on the line III-III in Fig. 2, shown in a position in which a sheet advances in a straight line.
Fig. 4 is a side elevation on the line IV-IV in Fig. 2 shown like Fig. 3 in a position in which the sheet moves forward in a straight line.
Fig. 5 is a cross-section on Fig. 3 shown in a position in which a sheet undergoes a rotary movement.
Fig. 6 is a side elevation of Fig. 4 shown like Fig. 5 in the position in which a sheet undergoes a rotary movement and
Fig. 7 is a time/distance diagram of sheets during the rotary movement according to the invention.

The rotating device 1 shown in Fig. 1 is incorporated in a feed table 2 of a folding device 3, along which feed table 2 copy sheets coming from a printing apparatus 4 can be fed directly to the folding device 3. The printing apparatus 4 is of a type in which sheets of receiving material of different (standard) formats pass through in the longitudinal direction, i.e. with their shortest side as the leading edge, so that they can be readily folded into a packet.

As described in the above-mentioned US patent 4 445 679, it is preferable to feed in the transverse direction to the folding device 4 a sheet having the dimensions of a folded packet, i.e. a sheet having its longest side as the leading edge. However, in the case of a printing apparatus 4 in which a powder image is fused on a receiving sheet by means of radiant heat, the radiation fuser required for the purpose requires a minimum length as considered in the sheet transit direction, for the radiation power to be supplied. In the case of a radiation fuser of this minimum required length, the said distance between transport rollers at the radiation fuser inlet and outlet may be too small to pass in the transverse direction sheets which do not require folding. In that case, this group of sheets, for example a group of sheets including the A4 format, must be fed longitudinally through the printing apparatus 4. For the sake of uniformity in inputting sheets it is also logical to feed all sheet formats for processing to the printing apparatus in the same orientation.

The folding device 3 is conventionally arranged to fold a supplied sheet into a packet of dimensions corresponding to the smallest standard format, e.g. the A4 format. The folding device of the type shown in Fig. 1 is illustrated and described in greater detail in European Patent 0 472 234. The folding device 3 of this type comprises a first folding section 5, in which a sheet fed longitudinally over the feed table 2 is folded zig-zag, the distance between two consecutive folds corresponding to the dimension of the shortest side of the smallest standard format, e.g. a size of 210 mm in the case of the A4 format. In a second folding section 6, the zig-zag folded sheet is folded in a direction at right angles to the first folds to the size of the longest side of the smallest standard format, i.e. to a size of 297 mm in the case of an A4 format. A copy sheet supplied in the smallest standard format, e.g. an A4 format, can be left unfolded. To this end, if such a sheet is passed through the folding device 3, so that the sheet can be placed on folded sheets so as to cover the same, the sheet must be fed transversely to the folding device 3.

In order, in the case of a folding device 3 coupled on-line to the printing apparatus 4, to allow both for the above requirements of the printing apparatus 4 with respect of the orientation of the smallest standard format, and the requirements of the folding device 4 with respect to the orientation of the smallest standard format, the feed table 2 is provided with a rotating device 1, which will be described with reference to Figs. 3 to 6, and which rotates through a quarter-revolution a sheet of the smallest standard format fed longitudinally through the printing apparatus, so that the sheet can be fed transversely into the folding device 3.

The printing apparatus 4 is provided with a pair of outlet rollers 8. Downstream thereof is a deflector 9 which in the position shown in Fig. 1 deflects a copy-sheet upwards for deposition in a tray 10 sloping above the printing apparatus 4. The deflector 9 can also be set to a position in which a copy sheet can be fed in the direction of the feed table 2 of the folding device 3.

On the upstream side, the feed table 2 is provided with pairs of transport rollers 11 and 12 while on the downstream side it has transport roller pairs 13, which roller pairs each form a number of transport nips distributed over the width of the feed table 2, as shown in Fig. 2. Between the transport roller pairs 12 and the transport roller pairs 13 two transport roller pairs 14 and 15 are disposed next to one another which, in addition to advancing over the feed table 2 the sheets for folding, also have a function in connection with rotating a sheet, as will be described hereinafter.

Copy sheets printed in the printing apparatus 4 which are larger than a group of sheets for passage unfolded by the folding device 3, are fed in a straight line over the feed table 2 by all the transport roller pairs 11 to 15 in the direction indicated by arrow 16 in Fig. 2.

When a copy sheet is supplied belonging to the group of sheets having a format requiring no folding, said sheet is turned through a quarter revolution on the feed table 2 in the manner to be explained hereinafter.

Rotation of a sheet on the feed table 2 is carried out when the sheet reaches the transport nip between the transport roller pairs 14 and 15. Rotation then takes place by retaining the sheet near one of said transport nips, namely near the transport nip formed by the transport roller pair 15, and releasing the transport rollers 15 from one another so that transport rollers 14 rotate the sheet about the centre of rotation 17.

During rotation, the sheet must remain free from the transport rollers 12 acting as input rollers and the transport rollers 13 acting as output rollers. In order to minimise the risk of the sheet being fed in a skew position by transport rollers pairs 14 and 15 in the case of the transportation of a sheet which does not require rotation, it is important that these transport roller pairs 14 and 15 should be as far apart as possible looking in a transverse direction to the transit direction 16. In the case of an A4 sheet fed in the longitudinal direction and having a width of 210 mm, the transport roller pairs can be up to approximately 150 mm apart to ensure that any laterally shifted sheet can be transported by the two transport roller pairs 14 and 15. In order further to ensure that a sheet is situated with its central line substantially on the same line in the transit direction 16 both before and after rotation through 90°, the centre of rotation 17 should be situated on a line which, calculated from the centre of the sheet for rotation, lies on a line forming an angle of 45° with the sheet sides. On the basis of the above considerations, the distance between the transport nips 14 and 15 and the location of the centre of rotation 17 somewhat upstream of the nips 14 and 15, a sheet for rotation must be transported with its leading edge over a distance A = 75 mm past the transport roller pairs 14 and 15 before rotation starts. This means that for the rotation of the largest sheet for rotation, which has a length B = 325 mm, the transport rollers 14 and 15 must be located at a distance downstream of the input rollers 12 which should be at least

$B - A = 325 - 75 = 250$ mm. Since the distance between the centre of rotation 17 and the point of the leading sheet edge situated furthest away from said centre of rotation in the case of the largest format of the group of sheets for rotation in a size of 325 x 230 mm is equivalent to approximately 200 mm, the distance C between the transport roller pairs 14 and 15 and the output rollers 13 should also be approximately 200 mm. Consequently the distance between the input rollers 12 and the output rollers should be at least $B - A + C$. In the case of the maximum sheet format for rotation, i.e. 325 x 230 mm this is therefore 325 - 75 + 200 = 450 mm. With some clearance between the leading and trailing edge of the sheet and the output rollers 13 and input rollers 12 respectively, a suitable free space for rotation between the input and output rollers is 460 mm. For rotation of a sheet, the centre of rotation 17 on the feed table 2 is formed by pressing the sheet by a rounded rubber cup against the feed table and simultaneously or slightly previously opening the transport nip between the transport rollers 15 closest to the centre of rotation 17. Given a continuous drive of the transport rollers 14 and 15 the transport nip 14 situated furthest away from the centre of rotation 17 rotates the sheet about the formed centre of rotation.

The opening of the transport nip is effected by lifting close to the transport roller pair 15 a shaft forming the connection between the pressure rollers of the transport roller pairs 14 and 15 by a lever having at one end the rubber cup forming the centre of rotation and, at the other end a lug as will be explained hereinafter with reference to an embodiment illustrated in Figs. 3 to 5. As illustrated in the top plan view of the feed table 2, a suitable location for the centre of rotation 17 is on the connecting line between the centre point of the sheet at the start of the rotation and the transport nip 15 for opening, the location being a short distance from said nip e.g. 40 mm. By tipping the connecting shaft between the pressure rollers of the transport roller pairs 14 and 15 on opening of the nip 15 the other nip 14 will form a more punctiform nip, and this is favourable to slip-free transport during rotation of the sheet. Since the punctiform transport nip 14 is also situated a short distance downstream of the centre of rotation 17 as considered in the transit direction said transport nip 14 exerts a small tractive force on the sheet, and this holds the sheet taut during rotation between the nip 14 and the centre of rotation 17.

Figs. 3 and 4 show the rotating device 1 of Fig. 2 in a position for passing a sheet in a straight line 16 through the rotating device. This position is occupied both on passage of a copy sheet which has to be folded in the adjoining folding device 3 and on transport of a sheet for rotation prior to and following on the rotation of the sheet.

The rotating device 1 comprises two transport roller pairs 14 and 15. Each transport roller pair 14 and 15 consists of a driven roller 20, 21 respectively fixed on a common drive shaft 22. Rollers 20 and 21 project somewhat above the feed table 2 formed by a plate. Each drive roller 20, 21 co-operates with a biasing roller 23, 24 respectively to form a transport nip. Biasing rollers 23, 24 are fixed on a common shaft 25 which fits by journals at the ends into slots (not shown) extending vertically.

Near the shaft 25 is disposed a pin 26 fixed in the apparatus frame. A T-shaped element 27 is fixed rotatably about said pin 26. The upwardly projecting limb 28 thereof is provided with a U-shaped recess in which a pin 29 fits which is fixed on an arm 30 movable to and fro between two positions by means of a solenoid 31. One arm 32 of the T-shaped element 27 is provided at its underside with a rounded rubber cup 33 and another arm 34 is situated beneath the shaft 25, so arms 32 and 34 acting as a lever. To perform a rotary movement, the solenoid 31 is actuated so that the T-shaped element 27 moves against spring action from the position shown in Figs. 3 and 4 to the position shown in Figs. 5 and 6. In these conditions arm 34 tilts shaft 25 up at the side of pressure roller 24 so that the transport nip between the rollers 21 and 24 is opened. On rotation of the T-shaped element 27, the rubber cup 33 is also pressed against the sheet lying on the feed table 2. Thus cup 33 forms the centre of rotation of 17 around which the sheet rotates on continuous transport of the sheet through transport rollers 20 and 23. As a result of the tilting of the shaft 25, biasing roller 23 presses, as already stated, against the drive roller 20 at substantially one point so that the angular velocity at which the sheet rotates is determined by the radius R. After the sheet has been turned through an angle of 90°, the rotation time being

$$t = 90° . \frac{R}{V}$$

where V is the circumferential speed of the drive roller 20, the solenoid 31 is deenergised so that biasing roller 24 again forms a transport nip and centre of rotation 17 is cancelled.

As shown in the distance/time diagram in Fig. 7, the sheet moves forward during rotation, as a result of the situation of the centre of rotation 17 on the leading half of the sheet fed in the longitudinal direction and at the side of the sheet so that the distance between the centre of rotation and the original leading edge is less than the leading edge after rotation. As a result of the continuous advance during rotation, a subsequent sheet can be supplied a short distance S after the rotating sheet without obstructing the latter, as will be apparent from Fig. 7.

In Fig. 7, the leading edge of a first sheet is indicated before rotation by line 40 and after rotation by line 41. The trailing edge is denoted by line 42 before rotation in Fig. 7 and by line 43 after rotation. For a subsequent sheet supplied at a distance S from the first sheet, the leading edge is denoted by lines 44 and 45 respectively and the trailing edge by lines 46 and 47 respectively. The starting and stopping time of the rotation of the first sheet is at the times 48 and 49 and for the next sheet is at times 50 and 51.

The angle α which forms the included angle between the direction in which the sheet moves straight ahead and the line between the transport nip which remains continuously operative and the centre of rotation formed can vary within specific limits without affecting good operation.

In the case of a 90° angle α, the transport force operative in the transport nip is at right angles to the line between said nip and the centre of rotation of the sheet. Thus in ideal conditions there is no slip in the transport nip. In the case of a 70° angle α the transport force in the nip can be broken down into a rotating force at right angles to the line between the nip and the centre of rotation and a (small) force operative in extension of said line and holding the sheet taut. If the angle α is too small, the latter force may produce unwanted slip in the transport nip. In the case of an angle α between the above limits, e.g. an angle α = 80°, a compromise can be found in which the sheet is kept taut during rotation without appreciable slip occurring in the transport nip, of course with some deformability of at least one of the transport rollers in the transport nip.

Claims

1. A method of rotating in a transport plane (2) a sheet advanced in a straight line in said plane in a direction of advance by a sheet transport means (14, 15), by retaining the sheet at a centre of rotation (17), characterised in that during the rotation the transport means (14, 15) forms solely one first transport nip (14) which, as considered in a direction transversely of the direction in which the sheet is advanced in a straight line, is situated at a fixed distance from the centre of rotation on a line between said first transport nip (14) and said centre of rotation (17), which line includes an angle α of between 70 and 90° with the direction of advance.

2. A method according to claim 1, characterised in that the angle α is between 75 and 85°.

3. A method according to claim 1 or 2, characterised in that prior to and subsequent to the execution of a rotary movement the sheet is also advanced through a second transport nip (15) which, as considered in the direction in which the sheet advances, is in an identical position to the first transport nip (14).

4. Apparatus for performing the method according to any one of claims 1 to 3, characterised in that the first transport nip (14) is situated at a predetermined distance from an upstream sheet feed nip (12) which is smaller than the length of the shortest sheet for processing and in that a sheet discharge nip (15) situated downstream of the first transport nip (14) is located at a distance from the sheet feed nip (12) somewhat greater than the diagonal of the largest sheet for rotation.

5. Apparatus for performing the method according to claim 3 comprising retaining means (33) movable between a first position (Figs. 3, 4) in which they are free of an advancing sheet and a second position (Figs. 5, 6) in which they retain the sheet at the centre of rotation (17), characterised in that coupling means (27) are provided between the retaining means (33) and the sheet transport means (14, 15) and on movement of the retaining means (33) from the first position to the second position move the sheet transport means (14, 15) from a position (Figs. 3, 4) in which the second transport nip (15) is closed to a position (Figs. 5, 6) in which the second transport nip (15) is open.

6. Apparatus according to claim 5, characterised in that both the first transport nip (14) and the second transport nip (15) are formed by pressure rollers (23, 24) which are fixed on a common shaft (25) and which can each press on drive rollers (20, 21) fixed beneath the transport plane (2) and in that the coupling means (27) are formed by an arm (32, 34) which tips the shaft (25) up against spring action at the side of the pressure roller (24) forming the second transport nip, on movement of the retaining means (33) from the first inactive position to the second active position.

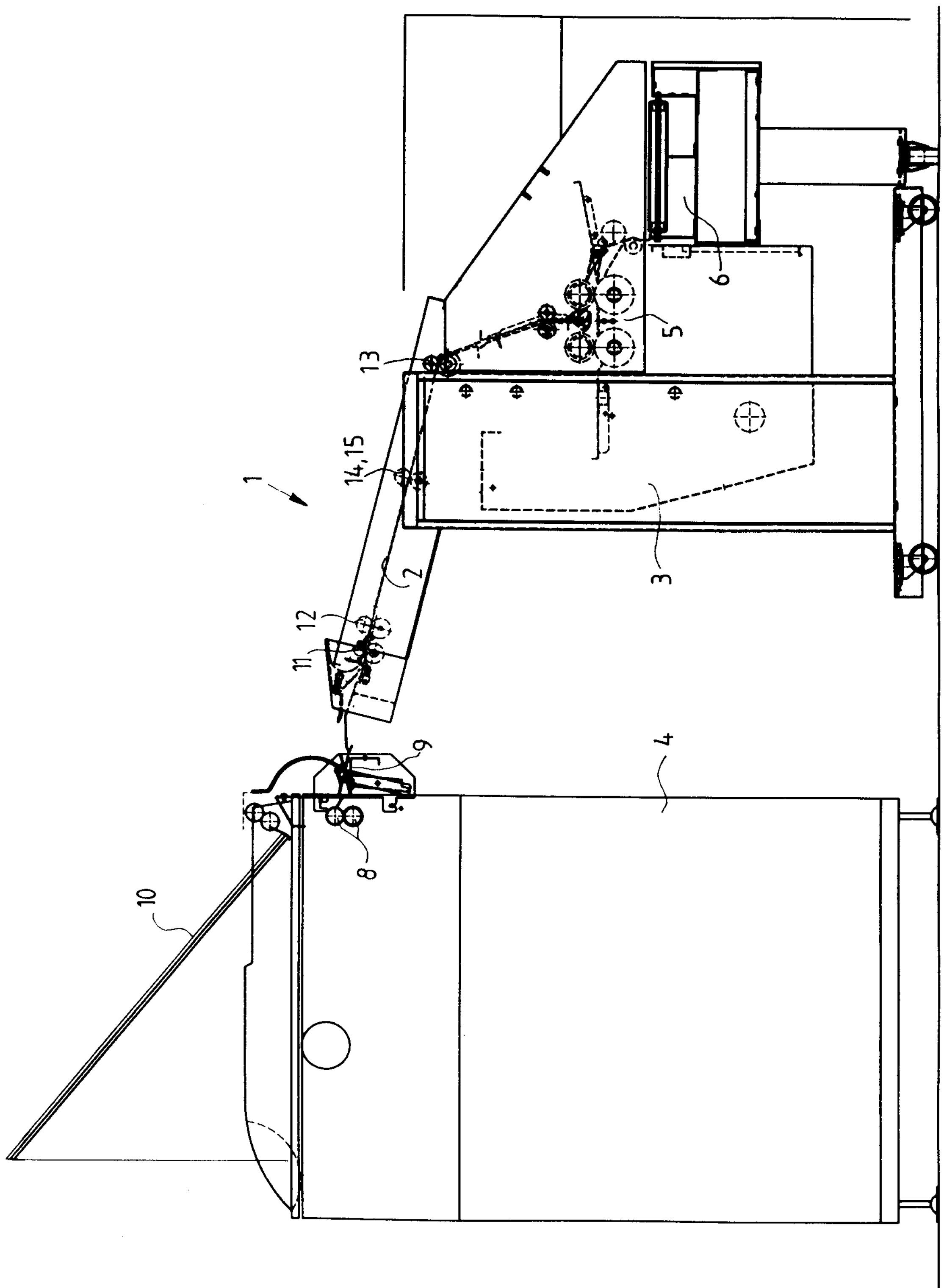

FIG.1

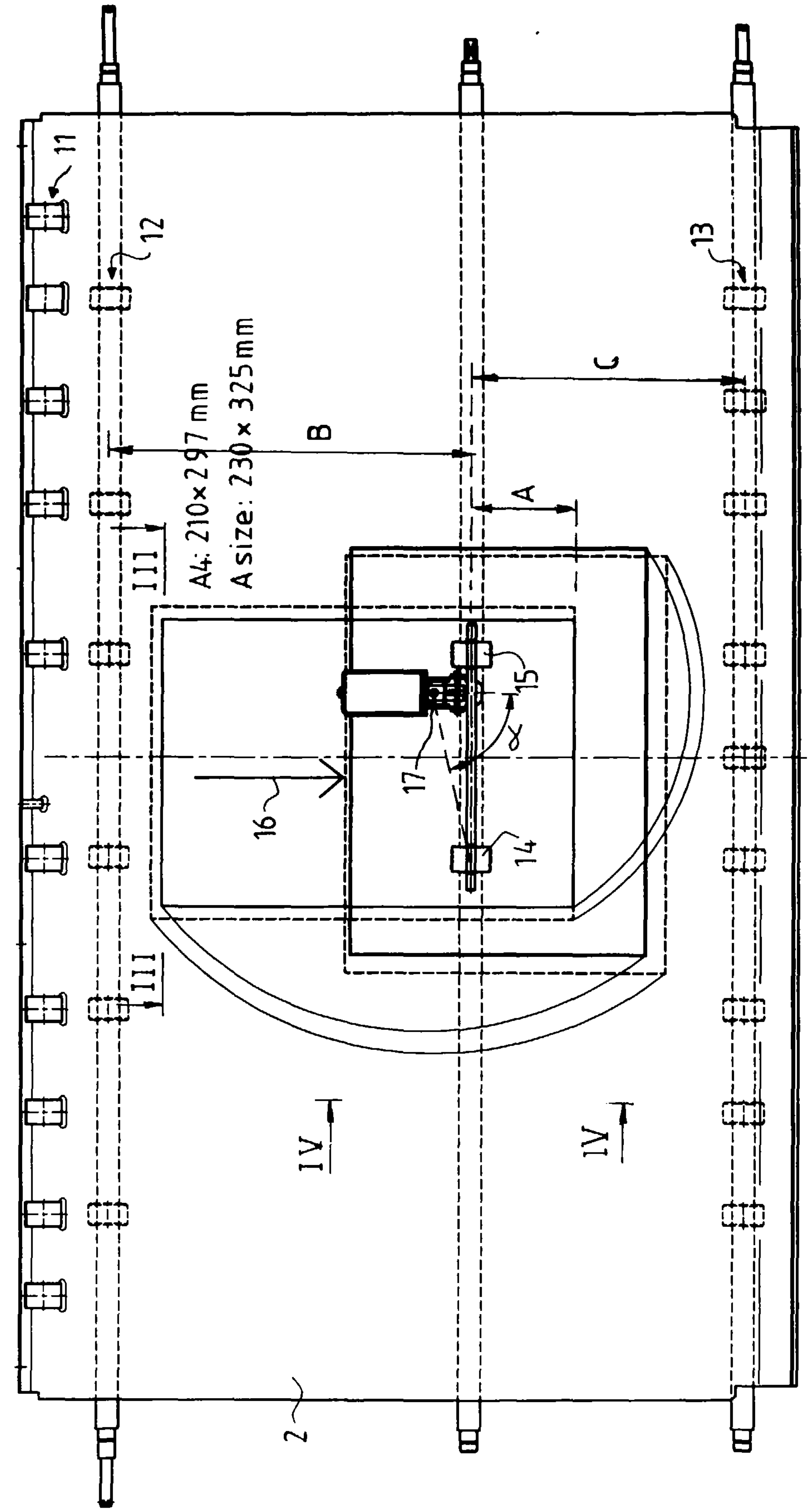
11
12
13
A4: 210×297 mm
A size: 230×325 mm
B
C
A
III
III
IV
IV
14
15
16
17
α
2

FIG. 2

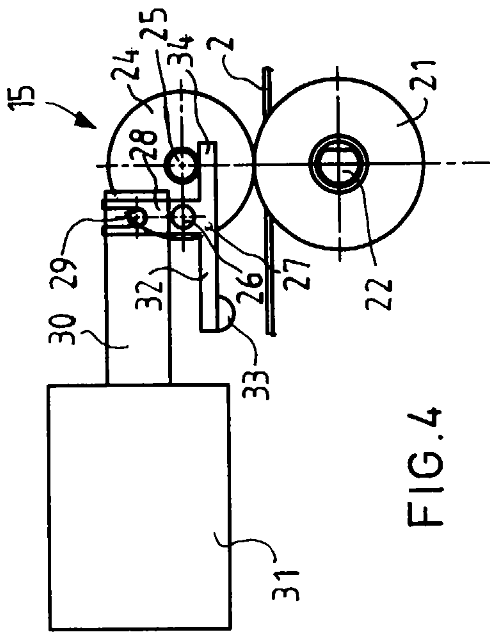

FIG.4

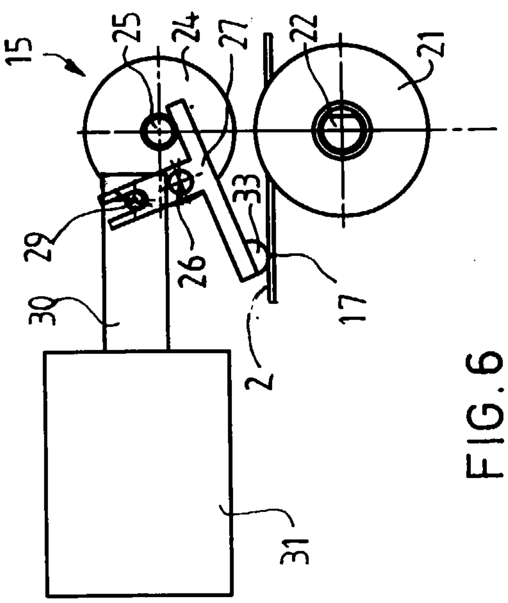

FIG.6

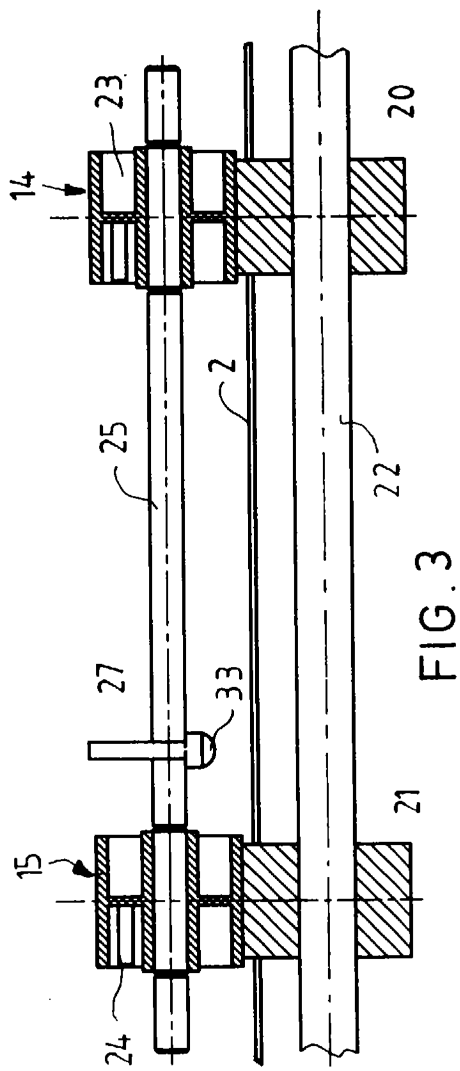

FIG. 3

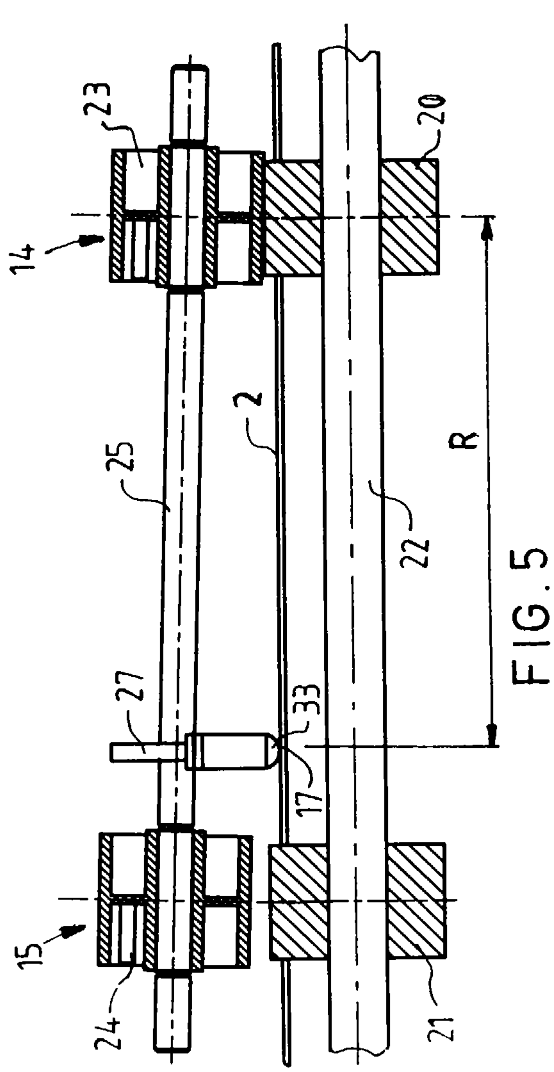

FIG. 5

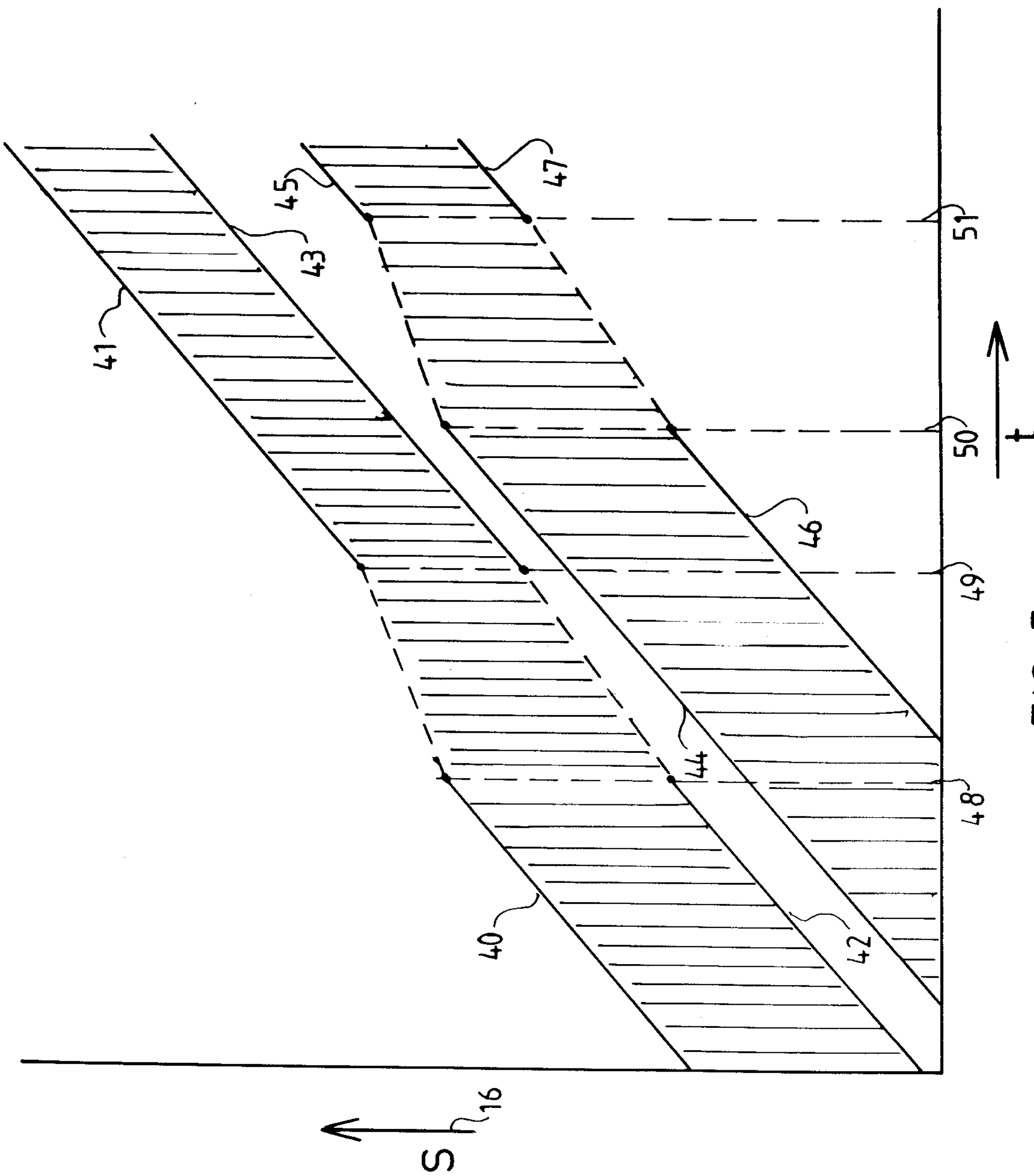

FIG. 7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 20 3087

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
D,A	US 4 445 679 A (BAY OTTO) 1 May 1984 * the whole document * ---	1-6	B65H5/18
A	US 5 320 340 A (BAY OTTO) 14 June 1994 * the whole document * -----	1-6	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B65H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	27 February 1998	Henningsen, O

CATEGORY OF CITED DOCUMENTS

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